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TECH TRENDS

The Applied Technologies Journal for Superfund Removals and Remedial Actions and RCRA Corrective Actions

Metals
Wetlands
Mine Drainage

Constructed Wetlands Remove Toxic Metals from Acid Mine Drainage

by Edward R. Bates, Risk Reduction Engineering Laboratory

Constructed wetlands as a treatment technology for toxic metal contaminated waters was effective in treating discharge of acid mine drainage from the Big Five Tunnel site near Idaho Springs, Colorado. The technology was evaluated under EPA's SITE (Superfund Innovative Technology Evaluation) Emerging Technology Program. An attractive feature of this technology is that, as a passive treatment system, the cost of operation and maintenance is significantly lower than that for active treatment processes.

Constructed wetlands use natural geochemical and biological processes inherent in a wetland ecosystem to accumulate and remove metals from influent waters. The treatment system incorporates organic substrates (synthetic soils), microbial fauna and sometimes algae and vascular plants. The removal methods try to utilize, rather than overcome, natural processes. From studies at Big Five Tunnel, it was determined that the important processes for raising the pH and removing metals were microbial sulfate reduction followed by precipitation of metal sulfides. Once it was found that microbial

(see **Wetlands**, page 2)

Conference Alert

EPA's 5th Forum on Innovative Hazardous Waste Treatment Technologies: Domestic & International will be at the Congress Hotel, Chicago, Illinois, on May 3–5, 1994. Using technical paper and poster presentations, this 3-day conference will introduce and highlight innovative treatment technologies having actual performance results. It will showcase results of selected international technologies, the U.S. EPA Superfund Innovative Technology Evaluation (SITE) Program technologies and case studies from those using innovative technologies. The overall objective is to increase the awareness of the user community of technologies ready for application at clean-up sites.

For more information contact: SAIC, Technology Transfer Department, 501 Office Center Drive, Suite 420, Ft. Washington, PA 19034. The numbers are: 800-783-3870 (toll free); 215-628-9317 (in PA); 215-628-8916 (FAX).

Superfund Remedial Actions

Project Status of Innovative Treatment Technologies as of June 1993

Technology	Predesign/ In Design	Design Complete/ Being Installed/ Operational	Project Completed	Total
Soil Vapor Extraction	69	32	6	107
Ex situ Bioremediation	22	11	1	34
Thermal Desorption	20	8	4	32
In situ Bioremediation*	16	9	1	26
Soil Washing	17	3	0	20
In situ Flushing	16	4	0	20
Dechlorination	3	1	1	5
Solvent Extraction	5	0	0	5
In situ Vitrification	3	0	0	3
Chemical Treatment	7	1	0	3
Other Innovative Treatment	2	0	1	8
TOTAL	**180 (69%)**	**69 (26%)**	**14 (5%)**	**263**

Note: Data are derived from 1982–1992 Records of Decision (RODs) and anticipated design and construction activities as of June 1993.

* Also includes *in situ* groundwater treatment.

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X-Ray Fluorescence Lead Survey

The report, "An X-ray Fluorescence Survey of Lead Contaminated Residential Soils in Leadville, Colorado: A Case Study," presents information on the use of field-portable X-ray fluorescence (FPXRF) to determine the spatial distribution of lead concentrations in residential soils contaminated from the California Gulch Superfund site in Leadville, Colorado. The report details the FPXRF program sample collection, preparation and analysis procedures, database management and program quality assurance efforts at Leadville. The program clearly demonstrates that small field portable X-ray fluorescence instrumentation can produce large quantities of acceptable quality data in a timely and cost-efficient manner. When combined with the results of blood lead level and bioavailability studies, these data can help to develop a true assessment of the risks

The report can be ordered from EPA's CERI at 513–569–7562. When ordering, please refer to the Document Number: EPA/600/R–93/073.

***Wetlands**, from page 1*

processes were primarily responsible for contaminant removal, it was realized that establishing and maintaining the proper environment in the substrate is the key to success for removal. Laboratory studies determined the best substrate combination for removal of the contaminants. Bench scale studies determined the optimum loading capacity and treatment system configuration. A staged design process comparable to the design process used for other wastewater treatment technologies was conceived.

First, it was decided that a trickling filter type of configuration achieved the best contact of the water with the substrate. Influent waters flowed through the aerobic and anaerobic zones of the wetland ecosystem. Metals were removed by filtration, ion exchange and chemical and microbial oxidation and reduction. In filtration, metal flocculates and metals that were adsorbed onto fine sediment particles settled in quiescent ponds or were filtered out as the water percolated through the soil or the plant canopy. Ion exchange occurred as metals in the water came into contact with humic or other organic substances in the soil medium. Oxidation and reduction reactions that occurred in the aerobic and anaerobic zones, respectively, played a major role in removing metals as hydroxides and sulfides.

Removal efficiency depended strongly on permeability and loading factors. Permeability of the substrate was found to be a critical design variable for successful operation in order to avoid hydraulic short-circuiting of the substrate and incomplete treatment. For the Big Five Tunnel studies, it was found that the loading factor of the influent should not exceed the 300 nanomoles/cm^3/day of sulfide generated by the microbes in the substrate.

By optimizing the process and determining how to properly load the wetland with contaminated drainage, the following results were achieved at Big Five Tunnel. The pH was raised from 2.9 to 6.5. Dissolved Cu, Zn, Cd, Ni and Pb concentrations were reduced by 98% or more. Iron removal was seasonal with 99% reduction in the summer. Mn reduction was relatively poor unless the pH of the effluent was raised above 7.0. Biotoxicity to fathead minnows and *Ceriodaphnia* was reduced by factors of 4 to 20 times. The initial concentration of metal contaminants had been high with Mn, 31 milligrams per liter (mg/L); Fe, 38 mg/L; Co, 0.10 mg/L; Ni, 0.15 mg/L; Cu 0.73 mg/L; Zn, 9.4 mg/L; Cd, 0.03 mg/L; and Pb, 0.03 mg/L.

As with any other wastewater removal technology, design of a constructed wetland or passive bioreactor is specific to the site and the water to be treated. For each site a staged design and development sequence similar to Big Five Tunnel should be planned which would include: laboratory studies to determine the best conditions and substrate; bench scale experiments to determine loading factors and substrate properties, including permeability; and pilot modules to test the performance of a typical field module.

In addition to treatment of acid mine drainage from metal or coal mining activities, the wetlands process is also suitable for leachates or wastewater that are mildly acidic or mildly alkaline and contain toxic metals. The technology has been applied with some success to wastewater in the eastern regions of the United States. The process may have to be adjusted to account for differences in geology. Constructed wetlands have been selected in Records of Decision for portions of the Clear Creek Site in Colorado and the Buckeye Landfill Site in eastern Ohio. Also, the SITE program is doing large-scale demonstration at the Burleigh Mine Tunnel on the Clear Creek site.

A complete report on the constructed wetlands technology entitled, *A Handbook for Constructed Wetlands Receiving Acid Mine Drainages* (Order No. PB93-233914AS), is available at a cost of $36.50 (paper) and $17.50 (microfiche) from: National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161 (phone: 703–487–4650). A shorter summary report, *Emerging Technology Summary: Handbook for Constructed Wetlands Receiving Acid Mine Drainage* (Document No. EPA/540/SR-93/523), is available at no cost and can be ordered by calling EPA's Center for Research Information (CERI) at 513–569–7562.

Mobile Soil Washing Unit Rids Soils of VOCs

by Teri Richardson, Risk Reduction Engineering Laboratory

VOCs
Soil Washing
Soil

The mobile Volume Reduction Unit (VRU) is a cost effective soil washing technology that rids soils of organic contaminants by suspending them in a wash solution and by reducing the volume of contaminated material through particle size separation. The VRU was developed by EPA's Risk Reduction Engineering Laboratory (RREL) and evaluated in a SITE (Superfund Innovative Technology Evaluation) Program demonstration at the Escambia Wood Treating Company Superfund Site in Pensacola, Florida. The 26-acre facility, now closed, used pentachlorophenol (PCP) and creosote-fraction polynuclear aromatic hydrocarbons (PAHs) to treat wood products from 1943 to 1982.

Initial feed soil concentrations, after homogenization and screening, ranged from 43 to 200 parts per million (ppm) for PCP and 480 to 1,500 ppm for PAHs. The demonstration found that removal efficiency was clearly enhanced by surfactant addition and pH and temperature adjustment, yielding an average of 97% PCP removal and 96% removal for PAHs. Treatment costs appear to be competitive with other available technologies. The cost to remediate 20,000 tons of contaminated soil using a 10 tons per hour VRU is estimated at $130 per ton if the system is on-line 90% of the time. Treatment costs increase as the percent on-line factor decreases. Projected unit costs for a smaller site (10,000 tons of contaminated soil) are $163 per ton; projected unit costs for a larger site (200,000 tons) are $101 per ton.

For this demonstration, the VRU was composed of two segments: soil washing and water treatment. The soil washing segment produced fines slurry and washed soil streams. The water treatment segment treated the fines slurry by separating the fines and removing pollutants from the wash water through a series of steps including sedimentation, flocculation, filtration and carbon adsorption. An additional series of unit operations, such as a trommel washer and dispersing agent (e.g., sodium hexametaphosphate) employed after vibrascreens, may help reduce the level of fines in washed soil even further.

The VRU system consistently and successfully segregated the contaminated soil into two unique streams: washed soil and fines slurry. The washed soil was safely returned to the site with no further treatment. The target cleanup levels were 30 ppm PCP, 50 ppm carcinogenic creosote and 100 ppm total creosote. Under conditions where surfactants were added and pH and temperature were adjusted, the washed soil contaminated concentrations dropped to 3 ppm PCP, 2.8 ppm carcinogenic creosote and 38 ppm total creosote.

The VRU system appeared not to be adversely affected by fluctuations in feed rate, wash water-to-feed ratio, wash water additives or other operating parameters. One of the primary objectives of the SITE demonstration was to determine whether or not the VRU could recover 80% of the volume of contaminated feed soil as clean washed soil. Greater than 80% soil recovery was achieved.

The VRU's effectiveness is based on its ability to separate soil fines (less than 100 mesh) from the coarser gravel and sand fraction of the soil (greater than 100 mesh). Significant contaminant concentration reductions can be realized by the VRU, provided the majority of the contaminants present in the feed soil concentrate in the fines. The data indicate the majority of the small particles were partitioned to the fines slurry. Only 1% to 2% of the large (greater than 100 mesh) particles were detected in the fines slurry. For the SITE demonstration, 10 mesh [2 millimeter (mm)] and 100 mesh (0.15 mm) separating screens were used.

Treated water from the VRU is potentially suitable for recycling as wash water, but it would likely require further treatment before being recycled. If the treated water cannot be reused as wash water, then it must be disposed of in accordance with applicable discharge requirements.

For more information, call Teri Richardson at EPA's RREL at 513–569–7949. Also, a six-page "Technology Demonstration Summary" (Document No. EPA/540/SR–93/508, and two detailed reports—*Applications Analysis Report* (Document No. EPA/540/AR–93/508) and *Technology Evaluation Report* (Document No. EPA/540/R-93/508)—can be ordered from the Center for Environmental Research Information (CERI) by calling 513–569–7562.

Public Meetings on Technology Innovation Strategy

EPA is hosting two public meetings in April to discuss the draft Technology Innovation Strategy (see p. 4). The April 6, 1994, meeting is from 9:00 a.m. to 4:00 p.m. at Sheraton Gateway Suites, 6501 N. Manheim Road, Chicago, Illinois 60018 (phone: 708–699–6300). The April 12, 1994, meeting is from 9:00 a.m. to 4:00 p.m. at the Ramada Renaissance Hotel, 13869 Park Center Road, Herndon, Virginia 22017 (phone: 703–478–2900). For more information, call Brendan Doyle at 202–260–3354.

EPA Administrator Browner Launches Innovative Technology Initiative

EPA Administrator Carol M. Browner announced a major new initiative to back up her stated goals "to establish procedures that allow EPA labs to be used to test and evaluate innovative technologies developed outside EPA" and "to expand the Agency's cooperative programs for developing, testing and evaluating specific categories of innovative technologies." The goal of the Environmental Technology Initiative (ETI) is to spur the development and use of more advanced environmental systems and treatment techniques that can be used in the United States and abroad. The ETI is funded at $36 million in FY 1994 and, in the President's plan, is to be funded at $80 million in FY 1995, with overall funding to be 1.8 billion over nine years.

In 1994, EPA has selected 73 projects that will be implemented with other partners including: Federal agencies, States, nonprofit groups and the private sector. Two of the projects that are being funded in 1994 are the Consortium for Site Characterization Technology (CSCT) and the LASAGNA Cooperative Research and Development Agreement (CRADA).

CSCT. The CSCT will provide and implement a performance validation process for innovative characterization technologies. The CSCT will be a multi-agency effort which will triage environmental monitoring needs so that technology developers will have guidance in meeting regulatory needs. It will also provide the users with credible performance information and methods. This program differs from the SITE program in the inclusion of other Federal agencies, such as the U.S. Department of Defense, U.S. Department of Energy and State regulators. The CSCT will provide different review and evaluation mechanisms from those currently used by SITE. The goal of the CSCT is the streamlining of the development, evaluation, acceptance and use of innovative site characterization technologies that meet performance-based criteria. EPA's Environmental Monitoring Systems Laboratory at Las Vegas (EMSL-LV) is active in the formation and coordination of the CSCT, with support from EPA's Office of Solid Waste and Emergency Response, Office of Federal Facilities Enforcement and Regions. For further information on the CSCT, contact Eric Koglin, Technology Transfer Officer at EMSL-LV (702–798–2432).

CRADA. On January 27, EPA Administrator Browner signed a CRADA with Monsanto, DuPont and General Electric companies to kick off a pilot project to develop and field test a new technology to treat contaminated dense (clay-like) soil. Dubbed the "lasagna" process, it involves the use of an electrical field to draw contaminants into layered areas called "treatment zones," created by soil fracturing. This method is designed to treat soil and ground water contaminants completely in place and be more effective than traditional waste remediation methods. This process could have widespread use in cleaning up hazardous waste sites and thus in reducing human exposure to hazardous waste. For further information contact Larry Fradkin at 513–569–7960.

Periodically, we will update you on the activities and products of these and other remediation-related projects funded under the ETI.

To order additional copies of this or previous issues of *Tech Trends*, or to be included on the permanent mailing list, send a fax request to the National Center for Environmental Publications and Information (NCEPI) at 513–891–6685, or send a mail request to NCEPI, 11029 Kenwood Road, Building 5, Cincinnati, OH 45242–0419. Please refer to the document number on the cover of the issue if available.

Tech Trends welcomes readers' comments and contributions. Address correspondence to: Managing Editor, *Tech Trends* (5102W), U.S. Environmental Protection Agency, 401 M Street, S.W., Washington, DC 20460.

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